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10. 09. 2003

(96)

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Concept House
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Newport
South Wales
NP10 8QQ

PCT/EP03/8942

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1/77

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office
Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference — PAAMBA197

2. Patent application number *(The Patent Office will fill in this part)* — 0219372.0 — 20 AUG 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Ashe Morris Limited
6 Christchurch Crescent
Radlett
Hertfordshire, WD7 8AH

Patents ADP number *(if you know it)* — 8135311001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — FABRICATION OF HEAT EXCHANGERS USING FLAT SIDE HEAT TRANSFER PIPES

5. Name of your agent *(if you have one)* — BAWDEN, Peter Charles

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Bawden & Associates
4 The Gatehouse
2 High Street
Harpenden
Herts
AL5 2SP

Patents ADP number *(if you know it)* — 07703572002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number or earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	5
Claim(s)	
Abstract	
Drawing(s)	

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I / We request the grant of a patent on the basis of this application.

Signature [signature] Date 20 Aug 02

12. Name and daytime telephone number of person to contact in the United Kingdom: Peter Charles BAWDEN 01582 466700

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent of the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or have any questions, please contact the Patent Office on 0645 500505.

b) Write your answers in capital letters using black ink or you may type them.

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d) If you have attached 'Yes' Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

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Fabrication of heat exchangers using flat side heat transfer pipes.

This document describes an improved fabrication method for building heat exchangers with external jackets, half coils, plenums or any other external flow conduit.

The technique described here represents an improved fabrication method for a variety of heat exchangers in the food, pharmaceutical and chemical industry.

This method is a better technique for fabricating batch vessels that currently rely on external jackets or half coil jackets.

This method is a better technique for fabricating a variety of reactors including bioreactors, crystallisers, evaporators, chemical reactors and polymerisation reactors.

This method is a better technique for fabricating cross flow (heat transfer fluid) heat exchangers.

This method is a better technique for fabricating variable area heat exchangers.

To illustrate this concept, a jacketed vessel will be used as the example. The principle however applies equally well to any other externally heated or cooled equipment such as jacketed pipes, mixers evaporators etc.

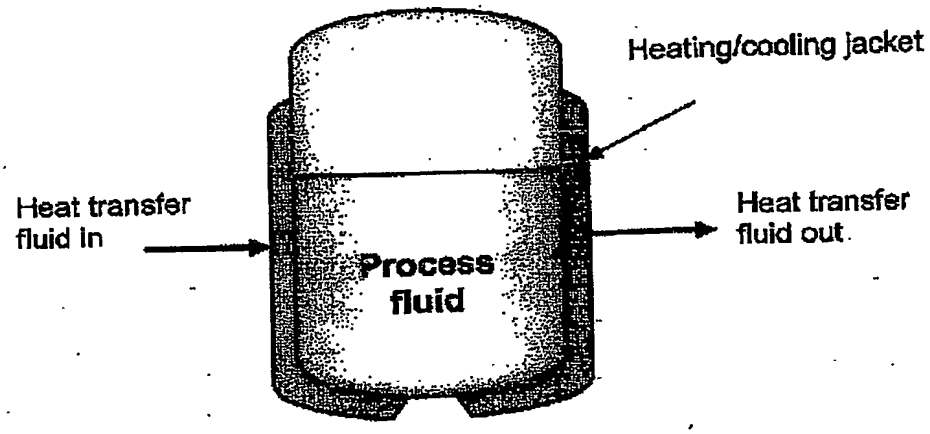

Figure (a) Jacketed vessel

Figure (a) illustrates a conventional batch vessel with external heating/cooling. Heat transfer fluid is pumped around the vessel via an external chamber (jacket).

An improved method to the conventional jacketed vessel is the half coil jacket as shown in figure (b). The half coil consists of a half pipe wrapped around the body of the vessel. The heat transfer fluid is introduced into the coil and taken off at one or several points.

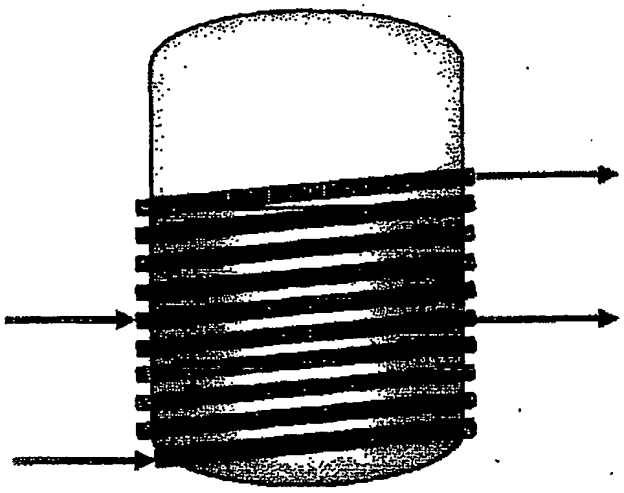

Figure (b) Jacketed vessel with half coil jacket.

The half coil jacket offers better heat transfer coefficients and better heat transfer fluid distribution.

The half coil method of fabricating heat exchangers is an effective technique. It is essentially consists of a pipe cut in half longitudinally and wrapped around the heat transfer surface as shown in the figure (c).

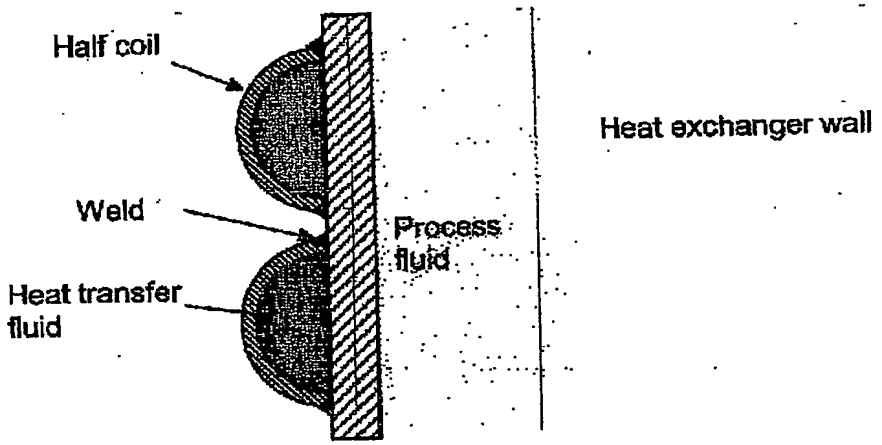

Figure (c) Section cut through a half coil

The example in figure (c) offers good heat transfer characteristics as there is no pipe wall between the heat transfer fluid and the heat transfer surface. However, it is a relatively difficult to fabricate.

The alternative to the half coil is a pipe welded to the heat transfer surface as shown in figure (d).

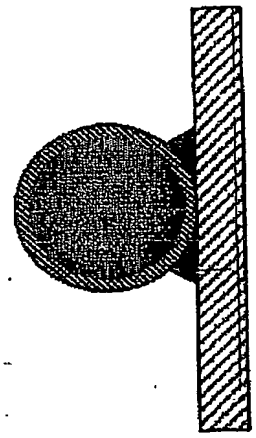

Figure (d) Heat transfer fluid pipe welded to heat transfer surface.

The disadvantage with the example shown in figure (d) is that the heat transfer properties are compromised by the additional thickness of metal through which the heat has to travel.

This problem can be overcome by using a heat transfer pipe with a flat side, an example of which is shown in figure (e).

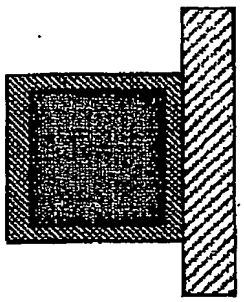

Figure (e) Flat sided heat transfer fluid pipe welded to heat transfer surface.

The shape of the pipe in figure (e) can be D shaped, square, rectangular or any other shape providing a flat face is in contact with the heat transfer surface.

Because the pipe is complete (and not cut through longitudinally), no welding is required. It is important however to eliminate air gaps between the pipe and the heat transfer surface. For this reason, the pipe should be fixed to the heat transfer wall by a continuous layer of material with good thermal conductivity properties. Good materials include: solder, silver solder, braising, thermally conductive epoxy cement or any other bonding material with good thermally conductive properties.

A pipe with a non-round cross section is not as strong as a pipe with a round cross section. This, however, can be compensated for by using thicker walls. In practice, pipes used for cross flow are inherently stronger by virtue of smaller cross sectional areas.

Because the heat transfer fluid pipe is smaller in diameter (and not in contact with the process fluid), materials with superior thermal conductivity can be used. Copper for example is an ideal heat transfer fluid pipe material. An external copper heat transfer fluid pipe would have negligible effect on the heat transfer properties of a typical industrial reactor as the table below illustrates.

Table of equivalent material thicknesses

Equivalent thicknesses of materials compared to copper.
This table illustrates the thickness of heat transfer wall that is equivalent to the additional thickness of the copper wall.

Copper wall thickness	2 mm
Equivalent thickness of stainless steel	< 0.1 mm
Equivalent thickness of Hastelloy C	< 0.06 mm
Equivalent thickness of glass	< 0.01 mm

In most cases, the penalty for using an external copper coil rather half coil would be much less than 1% (in terms of lost heat transfer capacity). This is more than compensated for by the improvement in the heat transfer fluid film coefficient which can be achieved by using a large number of small pipes.

This technique represents a much simpler and cheaper method of fabricating heat transfer equipment with external heat transfer surfaces. It also makes the fabrication of cross flow (heat transfer fluid) heat exchangers simple, since each heat transfer tube can be piped directly to a manifold.

This technique can be applied to any heat exchanger where the heat transfer fluid is delivered to an external jacket, half coil or plenum. This includes air or gas heaters, heated pipes, heated conveyors etc.